

REMARKS

This application has been revised and the following remarks are submitted in light of the Office Action mailed August 16, 2004. Claims 20 and 23-39 are presented for examination. Claims 21 and 22 have been canceled. Claim 20 has been amended to incorporate the limitations of Claims 21 and 22, and to correct an informality. Claims 23 and 24 have been amended to depend from Claim 20. No new matter has been added.

Applicants note that in the Office Action Summary, item 10 indicates that the drawings are objected to by the Examiner. The Office Action, however, provides no explanation regarding the substance of this objection. Therefore, Applicants are unable to provide replacement drawing sheets in response to this apparent objection.

Objection to Claim 20

Claim 20 is objected to because of the following informality: It is suggested that in line 10, "dielectric" be replaced with —hardmask—.

Claim 20 has been amended in accordance with this suggestion. Applicants therefore submit that this claim objection has been overcome.

Rejection of Claims 20, 27, 31, 33 and 37 under 35 U.S.C. § 102(e) over Wang

Claims 20, 27, 31, 33 and 37 are rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent Application Pub. No. 2002/0100907 by Wang. Applicants respectfully traverse this rejection.

Claim 20 is directed to a method of forming an interconnect structure formed on a substrate. It is a feature of amended Claim 20 that the method comprises depositing a first material on the conductor by a high density plasma chemical vapor deposition (HDP CVD) process, thereby forming a first cap layer, and depositing a second material on the first cap layer by a plasma-enhanced chemical vapor deposition (PE CVD) process, thereby forming a second cap layer. Applicants respectfully submit that this feature (at least) is not disclosed by Wang, as follows.

FIS9-2001-0295-US2

Wang is directed to a metal-to-metal antifuse structure and fabrication method. The method comprises depositing a first cap layer 28 "using conventional deposition techniques" (paragraph [0019]), and depositing a second cap layer 38 "using conventional techniques" (paragraph [0023]). Wang fails to disclose the particular combination of deposition techniques recited in Claim 20, i.e., a first cap layer being deposited by a HDP CVD process and a second cap layer being deposited by a PE CVD process.

Since Wang fails to disclose the above-identified feature of this invention, Applicants submit that Claim 20 is not anticipated by Wang. Claims 27, 31, 33 and 37, which include all of the limitations of Claim 20, are also not anticipated by Wang. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 21-25 under 35 U.S.C. § 103(a) over Wang in view of Jang

Claims 21-25 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang in view of Applicant's Prior Art (APA) and further in view of U.S. Patent No. 6,503,818 to Jang. Initially, Applicants note that Claim 21 and 22 have been canceled, and therefore submit that the rejection of these claims is now moot. With respect to Claims 23-25, Applicants respectfully traverse this rejection.

Claims 23-25 depend from Claim 20. It is a feature of amended Claim 20 that the method comprises depositing a first material on the conductor by a HDP CVD process, thereby forming a first cap layer, and depositing a second material on the first cap layer by a PE CVD process, thereby forming a second cap layer. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Wang in view of APA and further in view of Jang, as follows.

While HDP CVD and PE CVD deposition processes are well-known techniques for depositing individual cap layers, Applicants have surprisingly discovered that an interconnect structure comprising at least two cap layers formed by the particular combination of deposition techniques recited in Claim 20 yields a structure having superior reliability.

As discussed previously, Wang fails to disclose the particular combination of deposition techniques recited in Claim 20, i.e., a first cap layer being deposited by a HDP CVD process and a second cap layer being deposited by a PE CVD process. Wang also fails to suggest such combination, stating only that his cap layers are deposited "using conventional deposition techniques".

The Jang patent fails to remedy the deficiencies of the Wang disclose in this regard. Jang discloses formation of a delamination-resistant multi-layer composite dielectric layer. The Jang structure in, for example, Figure 3 comprises a silicon containing dielectric layer 18 formed by a method such as CVD, PE CVD and HDP CVD. Jang, however, fails to disclose or even suggest a structure comprising at least two cap layers, formed using the particular combination of deposition techniques recited in Claim 20. Jang, therefore, fails to provide any motivation to modify the teaching of Wang in this regard.

Accordingly, Applicants submit that Claim 20 is patentable over Wang in view of APA and further in view of Jang. Claims 23-25, which include all of the limitations of Claim 20, are also patentable over Wang in view of APA and further in view of Jang. Applicants therefore request withdrawal of this rejection.

Rejection of Claim 26 under 35 U.S.C. § 103(a) over Wang in view of Ngo et al.

Claim 26 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang in view of U.S. Patent No. 6,528,432 to Ngo et al. Applicants respectfully traverse this rejection.

Claim 26 depends from Claim 20. It is a feature of amended Claim 20 that the method comprises depositing a first material on the conductor by a HDP CVD process, thereby forming a first cap layer, and depositing a second material on the first cap layer by a PE CVD process, thereby forming a second cap layer. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Wang in view of Ngo et al., as follows.

As discussed previously, Wang fails to disclose the particular combination of deposition techniques recited in Claim 20, i.e., a first cap layer being deposited by a

HDP CVD process and a second cap layer being deposited by a PE CVD process. Wang also fails to suggest such combination, stating only that his cap layers are deposited "using conventional deposition techniques".

Ngo et al. fail to remedy the deficiencies of the Wang disclosure in this regard. The Ngo et al. patent is directed to a plasma treatment containing H₂ or H₂/N₂ to prevent degradation of organic ILD materials. Ngo et al. fail to disclose or even suggest the formation of an interconnect structure comprising at least two cap layers formed using the particular combination of deposition techniques recited in Claim 20. Ngo et al. therefore provide no motivation to modify the teaching of Wang in this regard.

Accordingly, Applicants submit that Claim 20 is patentable over Wang in view of Ngo et al. Claim 26, which includes all of the limitations of Claim 20, is also patentable over Wang in view of Ngo et al. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 28-30 under 35 U.S.C. § 103(a) over Wang in view of Ngo et al.

Claims 28-30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang in view of APA and further in view of U.S. Patent No. 6,528,432 to Ngo et al. Applicants respectfully traverse this rejection.

Claims 28-30 depend from Claim 20. It is a feature of amended Claim 20 that the method comprises depositing a first material on the conductor by a HDP CVD process, thereby forming a first cap layer, and depositing a second material on the first cap layer by a PE CVD process, thereby forming a second cap layer. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Wang in view of APA and further in view of Ngo et al., as follows.

As discussed previously, Wang fails to disclose the particular combination of deposition techniques recited in Claim 20, i.e., a first cap layer being deposited by a HDP CVD process and a second cap layer being deposited by a PE CVD process. Wang also fails to suggest such combination, stating only that his cap layers are deposited "using conventional deposition techniques".

Ngo et al. fail to remedy the deficiencies of the Wang disclosure in this regard. The Ngo et al. patent is directed to a plasma treatment containing H_2 or H_2/N_2 to prevent degradation of organic ILD materials. As discussed previously, Ngo et al. fail to disclose or even suggest the formation of an interconnect structure comprising at least two cap layers formed using the particular combination of deposition techniques recited in Claim 20. Ngo et al. therefore provide no motivation to modify the teaching of Wang in this regard.

Accordingly, Applicants submit that Claim 20 is patentable over Wang in view of APA and further in view of Ngo et al. Claims 28-30, which include all of the limitations of Claim 20, are also patentable over Wang in view of APA and further in view of Ngo et al. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 32, 34-36 under 35 U.S.C. § 103(a) over Wang in view of Ngo et al.

Claims 32 and 34-36 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang in view of U.S. Patent No. 6,593,237 to Ngo et al. Applicants respectfully traverse this rejection.

Claims 32 and 34-36 depend from Claim 20. It is a feature of amended Claim 20 that the method comprises depositing a first material on the conductor by a HDP CVD process, thereby forming a first cap layer, and depositing a second material on the first cap layer by a PE CVD process, thereby forming a second cap layer. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Wang in view of Ngo et al., as follows.

As discussed previously, Wang fails to disclose the particular combination of deposition techniques recited in Claim 20, i.e., a first cap layer being deposited by a HDP CVD process and a second cap layer being deposited by a PE CVD process. Wang also fails to suggest such combination, stating only that his cap layers are deposited "using conventional deposition techniques".

Ngo et al. fail to remedy the deficiencies of the Wang disclosure in this regard. The Ngo et al. patent is directed to a method of manufacturing a low-k stop layer for interconnects. Ngo et al. disclose, in Figure 3, various stop layers including

first channel stop layer 214, via stop layer 220, second channel stop layer 222 and next channel stop layer 224. These stop layers are deposited using plasma deposition (see, e.g., col. 3, lines 18-20). However, Ngo et al. fail to disclose or even suggest the formation of an interconnect structure comprising at least two cap layers formed using the particular combination of deposition techniques recited in Claim 20. Ngo et al. therefore provide no motivation to modify the teaching of Wang in this regard.

Accordingly, Applicants submit that Claim 20 is patentable over Wang in view of Ngo et al. Claims 32 and 34-36, which include all of the limitations of Claim 20, are also patentable over Wang in view of Ngo et al. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 38-39 under 35 U.S.C. § 103(a) over Wang in view of Lage et al.

Claims 38-39 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang in view of U.S. Patent No. 6,184,073 to Lage et al. Applicants respectfully traverse this rejection.

Claims 38-39 depend from Claim 20. It is a feature of amended Claim 20 that the method comprises depositing a first material on the conductor by a HDP CVD process, thereby forming a first cap layer, and depositing a second material on the first cap layer by a PE CVD process, thereby forming a second cap layer. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Wang in view of Lage et al., as follows.

As discussed previously, Wang fails to disclose the particular combination of deposition techniques recited in Claim 20, i.e., a first cap layer being deposited by a HDP CVD process and a second cap layer being deposited by a PE CVD process. Wang also fails to suggest such combination, stating only that his cap layers are deposited "using conventional deposition techniques".

Lage et al. fail to remedy the deficiencies of the Wang disclosure in this regard. The Lage et al. patent is directed to a process for forming a semiconductor device. Lage et al. disclose that the insulating capping layer in their semiconductor structure is typically a nitride film, and may include a plurality of films (col. 4, lines 3-4).

However, Lage et al. fail to disclose or even suggest the formation of an interconnect structure in which the at least two cap layers are formed using the particular combination of deposition techniques recited in Claim 20. Lage et al. therefore provide no motivation to modify the teaching of Wang in this regard.

Accordingly, Applicants submit that Claim 20 is patentable over Wang in view of Lage et al. Claims 38-39, which include all of the limitations of Claim 20, are also patentable over Wang in view of Lage et al. Applicants therefore request withdrawal of this rejection.

Conclusion

Applicants respectfully submit that the present application is now in condition for allowance. If the Examiner has any questions or believes further discussion will aid examination and advance prosecution of the application, a telephone call to the undersigned is invited.

No fee is believed to be due for the submission of this amendment. If any fees are required, however, the Commissioner is authorized to charge such fees to Deposit Account No. 09-0458.

Respectfully Submitted,



Margaret A. Pepper
Attorney for Applicant
Reg. No. 45,008

International Business Machines Corporation
Dept. 18G, Bldg. 300-482
2070 Route 52
Hopewell Junction, NY 12533

Phone: (845) 894-4713
Fax: (845) 892-6363
e-mail: mpepper@us.ibm.com

FIS9-2001-0295-US2

12